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Bioaffinity Nanoparticle Probes for Bioimaging

Quantum dots (QDs) are tiny light-emitting nanoparticles that are emerging as a new class of fluorescent probes for biomolecular and cellular imaging. In comparison with organic dyes and fluorescent proteins, quantum dots have unique optical and electronic properties such as size-tunable light emission, improved signal brightness, resistance against photobleaching, and simultaneous excitation of multiple fluorescence colors. These properties are most promising for improving the sensitivity of molecular imaging and quantitative cellular analysis by 1-2 orders of magnitude. However, the use of quantum dots for single-molecule imaging inside live cells has encountered significant problems such as QD aggregation in living cells, difficulties in transport and molecular binding in the crowded intracellular environment, and problems in tracking individual QDs in three dimensions. Through this NIGMS P20 project, we have made progress in a number of key areas including (a) systematic examination of surface coatings on QD properties; (b) development of cell membrane permeable and endosome-disrupting quantum dots for intracellular delivery and imaging; (c) organic chemistry of epothilones and taxol derivatives for targeting microtubules and related cytoskeleton; (d) imaging and tracking of QD probes and molecular motors moving on microtubules; and (e) high-speed analysis of single nanoparticle data at nanometer spatial prevision. These advances have been published in a number of papers (see below), and have opened new possibilities in examining the inner workings of live cells at the single-molecule level.

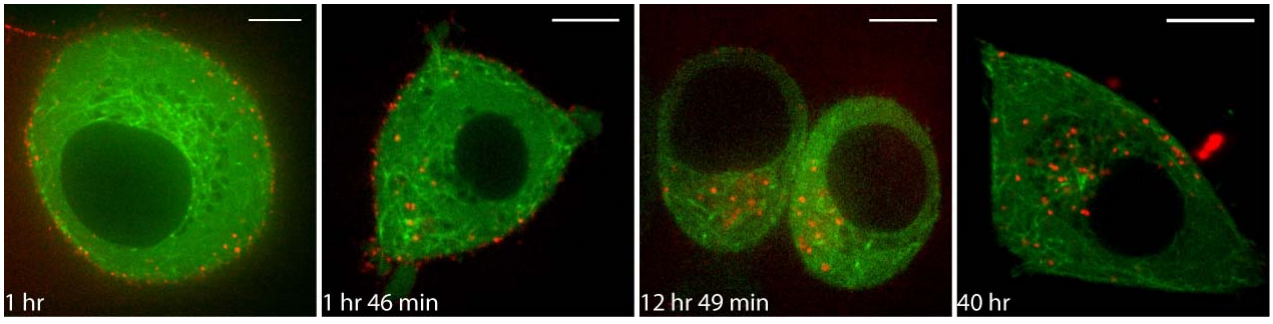

Figure 1. Real-time imaging and tracking of quantum dot probes in living cells.

Publications

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